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(54) ELECTRIC CONTACT AND BREAKER USING THE SAME

(57)Abstract:

PROBLEM TO BE SOLVED: To provide an excellent electric contact of Cd free Ag alloy applicable to a breaker.

SOLUTION: This electric contact is composed of Ag alloy containing 1-9 wt.% of Sn and In, and has a first layer of a surface part and a second layer on inner part. Hardness of the first layer and the second layer are 190 or more, and 130 or less respectively in micro Vickers standard regulated in JIS, and the thickness of the first layer is in a range of 10-360 μm. The electric contact is superior especially in welding resistance property and temperature characteristics.

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CLAIMS

[Claim(s)]
[Claim 1] Electric contact which consists of an Ag alloy of the chemical composition 1-9 mass % Containing both Sn and In, has the first pass of the surface section, and the second layer of the interior, is 190 or more and 130 or less, respectively, and has the thickness of the first pass within the limits of 10-360 micrometers on the micro Vickers criteria that the first pass and the degree of hardness of the second layer are specified to JIS.
[Claim 2] Electric contact according to claim 1 in which said Ag alloy contains at least one sort of elements further chosen from the group of Sb, calcium, Bi, nickel, Co, and Zn or Pb in addition to Sn and In.
[Claim 3] Electric contact according to claim 1 or 2 as the first pass with said chemical composition same at the second layer.
[Claim 4] The content of Sn in said first pass is the same as it of the second layer, or is more electric contact according to claim 1 to 3 than it.
[Claim 5] Electric contact according to claim 1 to 4 which has the thickness of said first pass within the limits of 30-120 micrometers.
[Claim 6] Electric contact according to claim 1 to 5 whose degree of hardness of said first pass is 240 or more on said criteria.
[Claim 7] The breaker using electric contact according to claim 1 to 6.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates mainly to the breaker using electric contact and it useful in the breaker (in this invention, these are only collectively called breaker below.) used for panelboards, such as a wiring breaker, a no fuse breaker, an earth leakage breaker, a circuit breaker, and a safety breaker.
[0002]
[Description of the Prior Art] Ag alloy with which oxides, such as Cd, Sn, and In, were distributed from the former has been widely spent on the ingredient of electric contact for breakers. That by which especially Cd oxide was distributed is suitable for this kind of electric contact, and has been widely used for the breaker. However, there is a toxic problem in Cd compound. For this reason, development of the so-called Cd free-lancer's Ag alloy with which oxides, such as Sn and In, were distributed as an ingredient of electric contact which replaces this becomes recent years, it comes to be wished strongly, many ingredients are developed, and it is used for many electrical machinery and apparatus.
[0003] Electric contact which consists of Cd free-lancer's Ag alloy is suitable for the device of a light load like the contactor which makes a problem comparatively the electrical machinery and apparatus and contact resistance of low loading with which the temperature characteristic is thought as important. However, when the rated current uses as electric contact for breakers of which more than 10A is required, compared with the thing containing Cd, the present condition is that the engine performance is inferior. For example, electric contact for which current uses electric contact in which many of breakers of 1.5kA or more of breaking current contained Cd more than 10 mass % more than 10A and which the rated current which is the main object of this invention becomes from an another side Cd free-lancer's Ag alloy is usually mainly used for the magnet switch, the relay, etc.
[0004] A joining-proof [(1)] property, the temperature characteristic in (2) initial stages, the temperature characteristic after (3) overload tests, the temperature characteristic after (4) durability tests, the insulating property after (5) blocking tests, the property [exhausting /-proof / (6)], etc. are mentioned to the property required of electric contact for breakers. When these properties are checked with the single ingredient of the same chemical composition and detailed organization, there is a property which has the relation of a trade-off, for example as shown in (1) and (2). Therefore, to use electric contact which consists of one ingredient, while has the relation of a trade-off and it is necessary to sacrifice demand characteristics in it. It is a joining-proof property the first of the property whose electric contact which consists of Cd free-lancer's Ag alloy must improve in order to change for electric contact containing Cd for breakers, and the second is the temperature characteristic which is in the relation between this and a trade-off with the same ingredient. Moreover, it is important for a breaker that it can stabilize and use in the field of comparatively high rated current and breaking capacity, and it needs to raise it to a certain amount of level also about the property [exhausting /-proof] or a barrier property. Then, while has the relation of a trade-off, it compound-ized with this combining another ingredient which excelled in the property, and the attempt used as a composite contact has been made.

The conventional technique comparatively near this invention is described below from the inside.
[0005] For example, the example of compound-izing appears in both the official reports of JP,58-189913,A and JP,62-97213,A. By arranging the ingredient the ingredient which was excellent in the property [exhausting /-proof] and the joining-proof property at the surface layer excelled [ingredient] in the barrier property at the inner layer, respectively, an Ag-Sn-In system alloy is arranged to a surface layer, and any electric contact of invention arranges the ingredient of high conductivity with many pure Ag and Ag contents to a inner layer substantially, respectively, and electric contact indicated by these devises it so that an arc piece may be improved.
[0006] While the former uses a surface layer as a thick eye (a surface layer is about 100-300 micrometers to inner layers being 300 thru/or about 1200 micrometers) considerably compared with a inner layer in preparation for the arc cutoff at the time of a short circuit The case where a surface layer is exhausted is considered and a concave convex joint is made on a boundary with a inner layer, and also after the surface layer above a joint **** with an arc, it devises so that a part of surface layer can be continued [it can be remained and] and used. On the other hand, although a surface layer is half-closed eyes (10-200 micrometers) for a while compared with the former, the latter makes [many] the amount of the oxide distributed by the surface layer in preparation for the arc cutoff at the time of a short circuit (the total amount of an oxide when [for example,] a surface layer is Ag alloy with which the oxide of Sn and In was distributed more than 10 mass %), and is raising the degree of hardness. Since these electric contact spends the alloy with many Ag and the amounts of Ag on the inner layer, it is thought that the arc piece time amount at the time of cutoff is short to be sure, but when using for the contact for breakers which intercepts a high current 6kA or more, immediately after a big arc occurs and a surface layer ****, we are anxious about the occurrence of joining accident. Moreover, the activity which puts irregularity into the mating face of up-and-down Ag alloy material, and is inserted in does not have bad economical productivity.
[0007] Moreover, it becomes JP,61-114417,A from Ag alloy containing Sn and In, and compound electric contact with few amounts of Sn of a surface layer, the oxide of In, especially the oxide of Sn than that of a inner layer is indicated. Therefore, since this contact consists of a surface layer of a low degree of hardness rather than a inner layer, when it uses as a contact for breakers, the property [exhausting /-proof] of a surface layer becomes low, and joining accident becomes easy to generate it. Furthermore, compound electric contact of another two-layer structure is introduced to JP,10-188710,A. The rated current targets the breaker below 100A for electric contact of this invention. Although two layers consist of a periphery layer which was mainly excellent in the joining-proof property, and a central layer which was mainly excellent in the temperature characteristic, they consist of an Ag alloy with which the oxide of Cd, Sn, and nickel was mainly distributed for both layers. By controlling the degree of hardness of both layers, and the rate of surface ratio of both the layers in the contact surface section by this contact, a joining-proof property and the temperature characteristic are mainly adjusted to a correct level. In addition, it of 135 or more and a inner layer of the degree of hardness of the periphery layer of this electric contact is less than 135 on micro Vickers criteria. Electric contact suitable for the breaker below rated current 100A is offered by this invention. However, since this contact contains a lot of Cd(s), it has a toxic problem.
[0008]
[Problem(s) to be Solved by the Invention] The technical problem of this invention is offering the breaker using electric contact useful in a breaker and this contact of 1.5kA or more of breaking current electric contact by which the joining-proof property which consists of an Ag alloy of Cd free-lancer who does not have a problem in toxicity, and has the relation of a trade-off, and the temperature characteristic were controlled proper, especially more than rated current 10A.
[0009]
[Means for Solving the Problem] 1-9 mass % About Sn and In, it consists of an Ag alloy of the chemical composition to include, and has the first pass of the surface section, and the second layer of the interior, and the first pass and the degree of hardness of the second layer are the micro Vickers criteria specified to JIS, and are 190 or more and 130 or less, respectively, and both this inventions are electric contact

which has the thickness of the first pass within the limits of 10-360 micrometers. Furthermore, this invention is the breaker which used this electric contact.

[0010]

[Embodiment of the Invention] Both electric contact of this invention has the chemical composition 1-9 mass % Containing Sn and In, and the remainder consists of Ag and an unescapable impurity. In addition, these components are usually distributed with the gestalt of a compound, especially an oxide in Ag matrix. The content of Sn is made into one to 9 mass % because the temperature characteristic of a contact will fall under by 1 mass %, if the joining-proof property of a contact deteriorates and exceeds 9 mass %. It is two to 7 mass % preferably. Moreover, the content of In is made into one to 9 mass % because the temperature characteristic of a contact falls in the case of this content out of range, and although it will be based also on the content of Sn if 9 mass % is exceeded to a pan, it is because a joining-proof property deteriorates. It is three to 7 mass % preferably.

[0011] It is because a joining-proof property and the temperature characteristic will fall if it becomes under this level to make the degree of hardness (usually 5g load load) of the first pass or more into 190 on micro Vickers criteria, and the degree of hardness of the second layer is made or less into 130 on micro Vickers criteria because a contact will carry out embrittlement and the property [exhausting /-proof] will fall, if this level is exceeded. The degree of hardness of the first pass is 240 or more, As for it of the second layer, it is desirable that it is 120 or less. In addition, the degree of hardness in this invention is checked on the micro Vickers criteria specified to JIS on the surface of the contact at the point of the arbitration of the first pass on a perpendicular cross section, and each second layer within the area. What is necessary is for degree-of-hardness distribution to be in the first pass and the layer of each second layer, and just to carry out clear [of the above-mentioned critical value] in electric contact of this invention, at the point of the arbitration in each class checked on the above-mentioned criteria.

[0012] Degree-of-hardness fall (it is 60 or more at micro Vickers criteria) is in the boundary line usually applied to electric contact of this invention from the first pass at the second layer, and there is a field (henceforth pars intermedia) which has the middle degree of hardness of both layers (that is, that degree of hardness is in within the limits exceeding under the minimum degree of hardness of the first pass and the upper limit degree of hardness of the second layer) in this boundary line. The thickness of this field changes by how much the entering condition of progress of the thermal diffusion between layers of an alloy content or processing distortion is mainly in Ag alloy phase at the time of manufacture. Furthermore, by electric contact of this invention, as long as it is within the limits of the configuration of claim 1, also in the boundary line of both layers, there is no above big degree-of-hardness fall, and you may fall in the thickness direction continuously or gradually one by one from a front face. such an inclination -- a functional organization can get by carrying out three or more layer laminating sticking by pressure of the Ag alloy material with which chemical composition differs, or controlling the heat treatment conditions in Ag alloy phase.

[0013] Thickness of the first pass is set to 10-360 micrometers. It is because a joining-proof property and the temperature characteristic fall, a contact will carry out embrittlement and the property [exhausting /-proof] and the temperature characteristic will fall under at a minimum, if an upper limit is exceeded. It is 30-120 micrometers preferably. Moreover, although a thing with pars intermedia is also contained in electric contact of this invention as mentioned above, as for the thickness of the said division in that case, it is desirable that it is 200 micrometers or less. If it exceeds 200 micrometers, the property [exhausting /-proof] and the temperature characteristic of a contact will become easy to fall. It is 100 micrometers or less preferably.

[0014] Through the core of a contact, using the piece of a cross-section trial perpendicular to a front face, the thickness of the first pass and the thickness of pars intermedia are the followings, and are made and checked. Five origins are first set up in the direction level on a front face on trial one side at equal intervals near a front face. subsequently, a degree of hardness is mostly checked at equal intervals one by one from a front face in the direction perpendicular (thickness) to a front face from the origin of these each, and five degree-of-hardness curves (in practice line graph) are drawn. Drawing 2 is a mimetic diagram for explaining a definition and how asking of the degree of hardness of the thickness of the first

pass and the pars intermedia of this invention, the first pass, and the second layer. In addition, in order to give explanation brief, only one of five is drawn on the Fig. The axis of abscissa expresses the distance from a front face for the degree of hardness as which an axis of ordinate is expressed in the Vickers criteria of JIS in drawing, respectively. The point of a black dot is observation data and is connected with the continuous line. The inside 31 and 32 of the horizontal line expressed with the broken line is a line which shows the arithmetic mean value level of the first pass and the degree-of-hardness observation data of the second layer, respectively. 33 and 34 are horizontal lines which show the degree-of-hardness level 190 and 130, respectively, and 41 and 42 are the intersections of a degree-of-hardness curve and these horizontal lines. All the inside of the first pass is 190 or more, and the observation degree of hardness of the contact of this invention is 130 or less altogether within the second layer. Since the first pass is thin, as for the case of only one point, a degree-of-hardness observation point makes the degree of hardness for convenience the degree of hardness of the first pass. In addition, the thing of the part except the thin layer in this layer (part with few oxide particles near [which is observed with an optical microscope] a contact center section) is used for the degree-of-hardness data used in case the average degree of hardness of the second layer is computed. Let the horizontal distance from a front face to an intersection 41, and thickness of pars intermedia be the horizontal distance during intersections 41 and 42 with the thickness of the first pass of this invention. In addition, although the thickness of pars intermedia is very thin and one case also has point data, an interlayer regards it as what is not for convenience in that case. From five degree-of-hardness curves, in the above procedure, the thickness of the first pass and the pars intermedia of the piece of a contact trial takes the thickness data of each first pass and pars intermedia, carries out the arithmetic mean of the five obtained data, and asks for them. The thickness data of the below-mentioned example are this arithmetic mean value. From five degree-of-hardness curves, in the above procedure, the first pass of the piece of a contact trial and the degree of hardness of the second layer take the minimum actual measurement of each first pass, and the maximum actual measurement of the second layer, carry out the arithmetic mean of the five obtained data, and ask for them. The average degree of hardness of the table of an example is this arithmetic mean value.

[0015] In addition, as mentioned above, when a degree of hardness carries out continuation change in the thickness direction at an inclination functional target, it decides for convenience on the following criteria. Distance to the point where, as for the thickness of the first pass, the degree of hardness of a front face to micro Vickers criteria becomes 190, and thickness of pars intermedia are made into the distance to the point where a degree of hardness becomes 130 from this point.

[0016] In addition to the above-mentioned fundamental component, at least one sort of elements further chosen from the group of Sb, calcium, Bi, nickel, Co, Zn, or Pb may be contained in electric contact of this invention as an accessory constituent. Usually, most of these components are distributed with the gestalt of a compound, especially an oxide in Ag matrix. However, the desirable variance range changes with each components. For example, it is 0.05-2 (Sb), 0.03-0.3 (calcium), 0.01-1 (Bi), 0.02-1.5 (nickel), 0.02-0.5 (Co), 0.02-8.5 (Zn), and 0.05-5 (Pb) per mass % by which the element conversion also of any were carried out. In addition, the inside of a parenthesis is an object element. In each above component kind, when the amount becomes out of range [the above], the temperature characteristic may fall depending on the class of breaker, and when especially an upper limit is exceeded, a joining-proof property may also fall to coincidence depending on the class of breaker.

[0017] Usually, although the above accessory constituent affects the engine performance of a contact a little, as components other than this, the following are mentioned, for example. ****** rare ** also cares about no these within the limits of the purpose of this invention. In addition, although a desirable content changes with components, what was displayed by the inner symbol of element of the numeric value in a parenthesis is the mass % unit by which element conversion were carried out, and the thing of a display with a molecular formula is the permission upper limit expressed per mass % by which isomerism child conversion were carried out. Ce, Li, Cr, Li, Sr, Ti, Te, Mn, AlF3, CrF3 and CaF2 (5), germanium and Ga (3), Si (0.5), Fe and Mg (0.1).

[0018] according to [as a result of this invention persons' having looked for the ingredient which fulfills

said demand characteristics of some which were carried out required for electric contact] the above basic configurations -- Cd -- it found out that the electric contact ingredient which combines the outstanding joining-proof property which could not be conventionally realized with a free ingredient, and the temperature characteristic could be offered.

[0019] It is within the limits of the above-mentioned basic configuration, and what is the chemical composition with the second same layer as the first pass is contained in this invention. Degree-of-hardness level differs with the chemical composition with both the same layers because each detailed organization is controlled by the below-mentioned means.

[0020] Moreover, it is in this invention within the limits of the above-mentioned basic configuration, and it is the same as it whose content of Sn in the first pass is moreover the second layer, or more things than it are also contained. It of the first pass becomes high almost certainly rather than the degree of hardness of the second layer by this. Therefore, what was suitable for said purpose of this invention is obtained.

[0021] In addition, in order to include electric contact of this invention in a breaker, it is necessary to connect it with other members, such as base metal. Therefore, in order to make connection with other members easily to the first pass of the second layer, with it, the thin connection layer which consists of metals, such as pure Ag and low material, may be prepared in the field of the opposite side. In addition, this layer should just be the same gestalt as the metal layer usually arranged for this kind of the purpose.

[0022] Next, the manufacture approach of electric contact of this invention is explained. The composite contact of this invention is made in the fundamental almost same procedure as this kind performed from the former of Ag alloy. For example, there are the following procedures in the dissolution and casting. After making the ingot dissolved and cast so that it may become the chemical composition of the first pass and each second layer first, and rolling these out coarsely, two sorts of rolled stock is stuck by pressure between heat. Thin connection layers, such as pure Ag described above as occasion demands after that in that case, are stuck by pressure. After rolling this out further and making it the shape of a hoop of predetermined thickness, this hoop is pierced, or it fabricates further, and considers as Ag alloy material of the size near the last configuration, internal oxidation of this material is carried out further, and metal components, such as Sn and In, are converted into an oxide. In addition, in advance of the dissolution and casting, compounds other than the oxide of a component element can also be included. Moreover, the process which adjusts heat treatment and a configuration suitably after rolling is put in if needed. In this case, the detailed organization of each class can be intentionally controlled by the device of heat treatment conditions, and a material property, its level, etc. can also be changed.

[0023] It can also make with powder-metallurgy processing. For example, after blending and mixing beforehand a compound besides detailed oxides, such as Sn and In, or the compound of these elements that become a new compound besides an oxide with heating, and the powder of Ag by two sorts of predetermined presentations, this is heat-treated as occasion demands. In a mold, the laminating and restoration of two sorts of obtained powder are carried out, it is pressed, and it considers as preforming. To this preforming, it extrudes between heat, and various kinds of plastic working, such as cold roll rolling between heat and hot forging, can be applied. The process which adjusts heat treatment and a configuration if needed after rolling is put in like casting furthermore described above. Property control of a request of each class is attained by the device of heat treatment conditions.

[0024] Moreover, after creating the material of the second layer in the procedure which applied correspondingly above, the first pass may be formed with various metallurgical means, such as the thick film screen printing by the thick-film formation by thermal spraying, CVD, etc., screen-stencil, etc., and with spreading after backing. Various means, such as diffused junction for example, by the hydrostatic molding method between heat and extrusion between heat, are applicable to junction of two more alloy plates. Moreover, by heat-treating, the detailed organization of each class can be controlled intentionally and a desired property can also be acquired.

[0025] Although there are various approaches illustrated below in the control means of a degree of hardness, if these are applied to the thing of the chemical composition especially with the first pass and the second same layer, they are effective. For example, there are rapid heating, an approach of

quenching and making residual stress of the first pass larger than that of the second layer, and the approach of performing shot-blasting processing only at the surface first pass, and work hardening only about the first pass of the composite contact obtained by the approach stated even to the above sentence knot. Moreover, in the approach described above, for example, after performing the so-called thermostat mechanical processing (thermoforming processing) which heat-treats to Ag alloy plate in addition to hot rolling or cold rolling, internal oxidation is performed, a needlelike oxide particle more detailed than the second layer is deposited in the first pass, and there is the approach of raising a surface degree of hardness. Moreover, there is the approach of performing by changing the training processing ratio of the first pass and the second layer in the case of strip processing mentioned above, for example or sticking by pressure between heat.

[0026] (Example 1) Ag alloy of two sorts of chemical composition, the first pass and the second layer, shown in the "chemical composition" column of Table 1 was dissolved and cast, and the ingot was produced. After roughing these, respectively, the ingot of the first pass and the second layer was stuck by pressure between heat with the roll between heat at 850 degrees C among superposition and argon atmosphere, and the compound material which consists of an Ag alloy of a bilayer was produced. After carrying out preheating of the obtained compound material under the same conditions as sticking by pressure between heat, the first pass stuck the thin pure Ag plate to the field of the second layer of the opposite side by pressure between heat so that it might finally become 1/10 of the thickness of the whole thickness. It cold-rolled further after that, and considered as the hoop-like material, this was pierced, and the composite contact chip of the configuration which is two of the configurations 2 width of face of 6mm, die length of 8mm, and whose configurations 1 with a thickness of 2.5mm, width of face and die length are 6mm and the thickness of 2mm was produced. The obtained chip was held at 750 degrees C among the oxygen ambient atmosphere of four atmospheric pressures for 170 hours, and was made into the piece of a composite contact trial. The thickness of the first pass of the obtained piece of a trial was as in Table 1, and the thickness of Ag layer was about 1 of each chip thickness/10.

[0027]

[Table 1]

試料番号	化学組成（質量%） 第一層 Sn	In	その他	第二層 Sn	In	その他	平均硬度 第一層 (Hmv)	第二層	第一層の厚み (μm)
* 1	0.8	0.9	−	0.6	0.7	−	170	59	50
2	1.2	1.2	−	1.2	1.2	−	192	65	50
3	2.3	2.2	−	2.2	2.1	−	195	70	50
4	2.3	9.0	−	2.2	2.1	−	193	79	50
5	9.0	3.1	−	2.2	2.1	−	250	125	50
6	3.4	3.4	−	3.2	3.1	−	240	110	50
7	5.0	5.0	−	5.0	5.0	−	280	112	50
8	7.0	7.0	−	7.0	7.0	−	290	125	50
9	8.0	7.5	−	7.8	7.2	−	302	127	50
*10	9.2	9.2	−	9.1	9.1	−	310	134	50
11	1.2	1.2	Sb	1.2	1.2	Sb	200	75	50
12	2.3	2.2	〃	2.2	2.1	〃	88	69	50
13	2.3	9.0	〃	2.2	2.1	〃	200	70	50
14	9.0	3.1	〃	2.2	2.1	〃	260	128	50
15	3.1	3.1	Ni	3.2	3.1	Ni	250	115	50
16	5.0	5.0	Ni	5.0	5.0	Ni	293	115	50
17	9.0	9.0	Bi	9.0	8.9	Bi	300	128	50
*18	9.2	9.2	〃	9.1	9.1	〃	320	139	50
*19	5.0	5.0	Sb他	5.0	5.0	Sb他	300	116	9
20	〃	〃	〃	〃	〃	〃	287	114	11
21	〃	〃	〃	〃	〃	〃	286	110	26
22	〃	〃	〃	〃	〃	〃	286	110	32
23	〃	〃	〃	〃	〃	〃	286	110	70
24	〃	〃	〃	〃	〃	〃	286	110	120
25	〃	〃	〃	〃	〃	〃	286	110	260
26	〃	〃	〃	〃	〃	〃	286	110	350
*27	〃	〃	〃	〃	〃	〃	286	110	370
28	〃	〃	Sb他	5.0	5.0	Sb他	282	113	50
29	〃	〃	Sb他	5.0	5.0	Sb他	285	102	50
30	4.0	3.0	Ni他	4.0	3.0	Ni他	270	100	50
*31	〃	〃	〃	〃	〃	〃	170	100	50
*32	〃	〃	〃	〃	〃	〃	270	132	50
33	7.0	7.0	−	7.0	7.0	−	290	125	50
34	7.0	7.0	−	7.0	7.0	−	293	128	50
*35	4.0	7.0		7.0	7.0		136	180	50
*36	3.4	3.4	−	−	3.1	−	150	68	200

注）＊印は比較例である。試料１１ないし１８のその他成分Ｓｂ、Ｎｉ、Ｂｉの量は、いずれも０．２質量％である。また試料１９ないし２７の第一層；第二層の化学組成は、いずれも同じであり、その他の成分とその量は、両層とも質量％単位でＳｂ、Ｃｏ、Ｚｎがいずれも０．１、Ｎｉ、Ｂｉがいずれも０．２である。試料２８のその他成分とその量は、質量％単位でＳｂ、Ｐｂ、Ｎｉ、Ｂｉ、Ｃｏ、Ｚｎがいずれも０．１、Ｃａが０．２である。試料２９のその他成分とその量は、質量％単位でＳｂ、Ｎｉ、Ｃａ、Ｂｉ、Ｃｏ、Ｚｎがいずれも０．１、Ｐｂが０．５である。試料３０ないし３２のその他成分とその量は、質量％単位でＮｉ、Ｚｎがいずれも０．２である。なお第一・第二層の化学組成は、表に記載された成分以外の残部は、Ａｇおよび不可避的不純物からなる。

[0028] In addition, while the sample group which a sample 1 thru/or 10 changed the amount of Sn and In, and controlled the degree of hardness of each class by Table 1, a sample 11, or 18 changes the amount of Sn and In, the sample group which added other components other than these further, a sample 19, or 27 is the sample group to which the thickness of the first pass was changed. Moreover, a sample 28 thru/or 34 are the things of the chemical composition with the same - second car layer for a start. As it was the following, the degree of hardness of the first pass was controlled by these things. First, a sample 28 thru/or 33 performed annealing in the middle of strip processing of a first pass material for allotropy material for 30 minutes at 450 degrees C among the vacuum, and added shot-blasting processing for 3 minutes by ****** 3 kgf/cm2 on the first pass front face with the alumina bead of #120 after internal oxidation further while it considered the strip-processing area ratio of the first pass as the increase of 50% of the second layer.

[0029] A sample 34 is produced on the same conditions as the above sample except having made the annealing temperature and time amount in the middle of strip processing into 750 degrees C and 5 hours, respectively. In addition, although not indicated in Table 1, by samples 33 and 34, the pars intermedia whose thickness is 190 micrometers and 230 micrometers, respectively was formed. In addition, it is the sample produced according to the approach by which the sample 35 was indicated by the **** No. 114417 [61 to] official report, and the sample 36 was indicated by each of JP,58-189913,A. That is, a sample 35 carries out internal oxidation of this on the same conditions as the above,

after sticking by pressure and rolling out Ag alloy of the first pass of chemical composition given in Table 1, and the second layer between the heat after dissolution casting. Moreover, a sample 36 forms width of face of 1mm, and irregularity with a depth of 0.5mm in an one direction level on the mating face of a mutual bilayer for Ag alloy of the first pass of chemical composition given in Table 1, and the second layer in 1mm pitch after dissolution casting, where a crevice and heights are mutually engaged in the part, it sticks them by pressure between heat, it is rolled out after that, and carries out internal oxidation of this on the same conditions as the above further. The degree of hardness of each sample and the thickness of the first pass which were produced by the above approach were checked in the above-mentioned procedure. The above result was shown in Table 1. In addition, although not indicated in a table, each thickness of the pars intermedia of a sample 33 and samples other than 34 was less than 100 micrometers.

[0030] Subsequently, the base metal made from electrolytic copper of the fixed side of a configuration like drawing 1 and a movable side was prepared, electric contact of a configuration 1 was carried out at fixed side base metal, and silver solder attachment of electric contact of a configuration 2 was carried out at movable side base metal, respectively. In addition, in drawing, 1 is electric contact, 2 is base metal, a shows a fixed side and b shows each assembly of a movable side. It fixed to two sorts of breakers, rated AC30 A-frame and 50 A-frames, after that. It prepared such five breaker assemblies each for every composite contact chip pair of each sample number. First, using all the assemblies of each sample, the rated current was energized for 100 minutes and the early temperature characteristic was checked. Next, by 220V loaded condition, in the case of 30 A-frames, it is 1.5kA breaking current, and it was 5kA breaking current, and in the case of 50 A-frames, the blocking test was respectively performed using the assembly per set, and it checked joining-proof nature. The temperature characteristic after a blocking test energized the rated current for 100 minutes succeedingly after that, and checked the temperature characteristic after a blocking test. The assembly which checked the initial temperature characteristic was used for the overload test, after 30 A-frames and 50 A-frames had passed the 5 times as many current as an identification rank current, it repeated closing motion 50 times at intervals of 5 seconds, and it checked the temperature characteristic after an overload test on the same conditions as the time of the initial check of the account of Gokami. The assembly which checked the initial temperature characteristic was used for the durability test, and it is in the condition in which 30 A-frames and 50 A-frames passed the identification rank current, repeated closing motion 6000 times at intervals of 5 seconds, and checked the temperature characteristic after a durability test on the same conditions as the time of the initial check of the account of Gokami.

[0031] In addition, the evaluation by these the trials of a series of synthesized the result according to model of 30A and 50 A car frame, evaluated it five steps, was made to correspond to the sample number of Table 1, and was shown in Table 2 by the phase number of 1-5. The engine-performance level which use improper level was excellent in 1 and 2 of a phase number, and was excellent in this use good level and especially 5 three or more as a breaker is hit. The same is said of the case of the following examples.

[0032]
[Table 2]

試料番号	電気試験の結果（5段階総合評価）				
	耐溶着特性	初期の温度特性	過負荷試験後温度特性	耐久試験後温度特性	短絡試験後温度特性
* 1	1	5	2	2	1
2	2	5	3	3	3
3	3	5	4	3	3
4	3	5	3	3	3
5	5	3	3	4	3
6	4	4	4	4	4
7	4	3	4	4	3
8	4	3	4	4	3
9	4	3	3	3	3
* 10	4	2	1	2	1
11	4	4	3	3	3
12	4	4	3	4	4
13	4	4	3	3	3
14	5	3	3	3	3
15	4	4	4	4	4
16	4	3	4	4	3
17	4	3	3	4	3
* 18	3	3	2	3	2
* 19	2	3	3	2	3
20	3	4	3	3	3
21	4	4	3	3	4
22	4	4	3	4	4
23	4	4	4	4	4
24	4	4	4	4	4
25	4	4	4	3	4
26	3	3	4	3	4
* 27	2	2	4	3	4
28	4	3	4	4	3
29	4	3	4	4	3
30	4	4	4	4	4
* 31	2	5	2	2	2
* 32	2	4	2	4	2
33	4	3	4	4	3
34	3	3	4	3	3
* 35	2	4	2	2	2
* 36	1	5	1	2	1

注）＊印は比較例である。

[0033] The above result shows the following things. (1) Control the first pass and the second layer of the amount of Sn and In within the limits of 1 - 9 mass %, make to 190 or more by the first pass, make the degree of hardness of the micro Vickers criteria of a JIS convention or less into 130 by the second layer, and the breaker using the contact of this invention which controlled the thickness of the first pass within the limits of 10-360 micrometers further is in sufficiently usable within the limits in the above-mentioned comprehensive evaluation. On the other hand, the breaker using the contact outside this invention range has not reached practical use level in comprehensive evaluation. (2) in addition to Sn and In, it is little **** about components, such as Sb and nickel, -- the same thing can be said also by the case. (3) The contact chip produced by the process indicated by each of JP,61-114417,A and JP,58-189913,A became out of range [degree-of-hardness level / this invention], and, as for the breaker assembly incorporating these, the engine performance of practical use level was not synthetically obtained except for some both properties.

[0034] (Example 2) The samples 3, 8, and 9 of Table 1, the first pass, and the chemical composition of the second layer produced the same composite contact. the second layer -- an example 1 -- it produced by the same approach and the first pass was formed by the low-pressure-plasma-spraying method on it. It consisted of an Ag alloy of the same chemical composition as the second layer first, and the material of the shape of same dimorphism as the example 1 which stuck the thin pure Ag layer to one field by pressure between heat was produced like the example 1. After that, into the vacuum chamber, the pure Ag layer was used as the rear face, each material was placed, and on the field on a side front, as it was the following, the first pass was formed. First, it is the same chemical composition as the first pass of the

samples 3, 8, and 9 of Table 1, and the end of Ag alloy pre-alloyed powder it has the particle size distribution from submicron one to 2 micrometers was prepared as a raw material. After that, as carrier gas for feed, argon gas was used, the material side of the second above-mentioned layer was made to spray and fix the end of pre-alloyed powder it prepared by the low-pressure-plasma-spraying method, and the first pass was formed. In addition, the tip of a thermal spraying gun is made to rock automatically during thermal spraying, and it was made for the first pass by which thermal spraying is carried out to become homogeneity. Moreover, in order to raise the degree of adhesion between the - second car layers for a start, the front face of the first pass was beforehand put to plasma flame before thermal spraying. Internal oxidation of the obtained compound-ized material was carried out on the same conditions as an example 1. The thickness of the first pass with any final chip was 50 micrometers, and the thickness of a pure Ag layer was about 1 of chip total thickness/10.

[0035] The degree of hardness of the - second car layer and the thickness of the first pass were checked like the example 1 for a start [of the obtained contact chip]. The result is shown in Table 3. In addition, although not indicated in a table, any sample of the thickness of the pars intermedia was less than 100 micrometers. These contact chips were attached to the breaker of isomorphism like the example 1, and the same procedure as an example 1 performed the electric trial. The result is also doubled and it is shown in Table 3.

[0036] The approach of forming the first pass by the spraying process from this result also shows that offer of the breaker which was excellent practically that casting, the first, and the chemical composition of the second layer are the same, and manufacture of compound electric contact of this invention within the limits is possible for a degree of hardness and by using this contact further is also possible.

[0037]

[Table 3]

試料番号	化学組成	平均硬度		電気試験の結果（5段階総合評価）				
		第一層 (mHv)	第二層	耐溶着特性	初期の温度特性	過負荷試験後温度特性	耐久試験後温度特性	短絡試験後温度特性
37	試料3に同じ	198	70	3	5	4	4	3
38	試料8に同じ	295	125	4	3	4	4	3
39	試料9に同じ	303	127	4	3	3	3	3

[0038] (Example 3) The samples 1, 2, 4, 5, and 6 of Table 1 and the chemical composition of both layers produced the same compound electric contact. the second layer -- an example 1 -- it formed by the same approach and the first pass was formed with vacuum deposition on it. It consisted of an Ag alloy of the same chemical composition as the second layer first, and the material of the shape of same dimorphism as the example 1 which stuck the thin pure Ag layer to one field by pressure between heat was produced like the example 1. After that, into the vacuum chamber, the pure Ag layer was used as the rear face, each material was placed, and the first pass was formed as it was the following subsequently to the field top on a side front. The target of the same chemical composition as the first pass of the samples 1, 2, 4, 5, and 6 of Table 1 was prepared first. In order that the temperature in a vacuum chamber might prevent the reevaporation of Sn, it kept at 180 degrees C, and holding this pressure to the argon partial pressure of gas of Number Torr - dozens Torr(s), it vapor-deposited this by the magnetron sputtering method using the above-mentioned target, and formed the first pass of the same presentation as this target in the material side of the second layer. In addition, in order to raise the degree of adhesion between the - second car layers for a start, it cleaned with the ion made to generate the front face of the first pass by the RF beforehand before vacuum evaporationo. It oxidized on the same conditions as an example 1, and the obtained compound-ized material was considered as the contact chip. The thickness of the first pass with any final chip was 50 micrometers, and the thickness of a pure Ag layer was about 1 of chip total thickness/10.

[0039] The degree of hardness of the - second car layer and the thickness of the first pass were checked

like the example 1 for a start [of the obtained contact chip]. The result is shown in Table 4. In addition, although not indicated in a table, any sample of the thickness of the pars intermedia was less than 100 micrometers. These contact chips were attached to the breaker of isomorphism like the example 1, and the same procedure as an example 1 performed the electric trial. The result is also doubled and it is shown in Table 4.
[0040]
[Table 4]
<IMG SRC="/NSAPITMP2/web512/IMAGE/20070621102751260275.gif" WIDTH="384" HEIGHT="195" ALT="ID=000005">

[0041] The approach of forming the first pass with vacuum deposition from this result also shows that offer of the breaker which was excellent practically that casting, the first, and the chemical composition of the second layer are the same, and manufacture of compound electric contact of this invention within the limits is possible for a degree of hardness and by using this contact further is also possible.
[0042] (Example 4) The material of compound electric contact with the same chemical composition of the - second car layer was produced in the same procedure as an example 3 for a start with the samples 2, 3, 7, 19, 20, 22, 24, 26, 27, 30, 31, and 32 of Table 1. After turning the front face by the side of the first pass of these materials up furthermore and having arranged in a shot-blasting chamber, shot-blasting processing was alternatively performed only for this front face with the alumina bead of #120. From the time of the usual shot-blasting finish-machining, ****** was made high, and was made into 6 kgf/cm2, and the conditions in that case projected it for 3 minutes. Internal oxidation was performed on the conditions same after that as an example 1, and it considered as the contact chip sample. The combination size of a final chip was the same as the example 1, each thickness of the first pass was 50 micrometers, and the thickness of a pure Ag layer was about 1 of chip total thickness/10.
[0043] The degree of hardness of the - second car layer and the thickness of the first pass were checked like the example 1 for a start [of the obtained contact chip]. The result is shown in Table 5. These contact chips were attached to the breaker of isomorphism like the example 1, and the same procedure as an example 1 performed the electric trial. The result is also doubled and it is shown in Table 5.
[0044] The approach of forming the first pass with vacuum deposition from this result, and work hardening the front face of that first pass further also shows [that casting, the first, and the chemical composition of the second layer are the same, and manufacture of compound electric contact of this invention within the limits is possible for a degree of hardness, and / offer of the breaker which was excellent practically by using this contact further, or] a thing.
[0045]
[Table 5]

試料番号	化学組成	平均硬度 第一層 (mH.)	平均硬度 第二層 (mH.)	電気試験の結果（5段階総合評価） 耐溶着特性	初期の温度特性	過負荷試験後温度特性	耐久試験後温度特性	短絡試験後温度特性
45	試料2に同じ	190	63	3	4	3	3	3
46	試料3に同じ	193	69	3	5	4	3	3
47	試料7に同じ	275	110	4	3	4	4	3
*48	試料19に同じ	287	114	2	5	3	2	3
49	試料20に同じ	287	114	3	4	3	3	4
50	試料22に同じ	286	110	4	4	3	4	4
51	試料24に同じ	286	110	4	4	4	4	4
52	試料26に同じ	286	110	4	3	4	3	4
*53	試料27に同じ	286	110	3	2	4	3	4
54	試料30に同じ	267	100	4	4	4	4	4
*55	試料31に同じ	170	100	2	5	2	2	2
*56	試料32に同じ	270	134	2	4	2	4	2

注）＊印は比較例。

[0046] (Example 5) The samples 7, 16, 21, 23, and 28 of Table 1 and the chemical composition of both layers produced the same compound electric contact. After carrying out dissolution casting and sticking the rolled stock of these ingots by pressure between **** by the first pass and second-layer presentation like an example 1, the thin pure Ag layer was stuck to the second layer side by pressure between heat, strip processing of this was carried out further, and it considered as the hoop material. After annealing these materials at 300 degrees C among the vacuum below 10-5 Torr furthermore for 2 hours, it pierced in the shape of [as an example 1 / same] dimorphism, and the compound-ized material was obtained. Internal oxidation of these materials was carried out in the same way as an example 1 after that, and it considered as the contact chip sample. The combination size of a final chip was the same as the example 1, each thickness of the first pass was 50 micrometers, and each thickness of a pure Ag layer was about 1 of chip total thickness/10.

[0047] The degree of hardness of the - second car layer and the thickness of the first pass were checked like the example 1 for a start [of the obtained contact chip]. The result is shown in Table 6. In addition, although not indicated in a table, any sample of the thickness of the pars intermedia was less than 100 micrometers. These contact chips were attached to the breaker of isomorphism like the example 1, and the same procedure as an example 1 performed the electric trial. The result is also doubled and it is shown in Table 6.

[0048] By annealing at temperature comparatively low before oxidizing Ag alloy material made and compound-ized with casting from this result shows that the chemical composition of the - second car layer is the same casting and for a start, and manufacture of compound electric contact of this invention within the limits is possible for a degree of hardness, and that offer of the breaker which was excellent practically by using this contact is possible.

[0049]

[Table 6]

試料番号	化学組成	平均硬度 第一層 (mH.)	平均硬度 第二層 (mH.)	電気試験の結果（5段階総合評価） 耐溶着特性	初期の温度特性	過負荷試験後温度特性	耐久試験後温度特性	短絡試験温度特性
57	試料7に同じ	278	110	4	3	4	4	3
58	試料16に同じ	290	115	4	3	4	4	3
59	試料21に同じ	286	110	4	4	3	3	4
60	試料23に同じ	286	110	4	4	4	4	4
61	試料28に同じ	284	110	4	4	4	3	4

[0050] (Example 6) The samples 6 and 8 of Table 1 and the chemical composition of both layers produced the same compound electric contact. Like the example 1, dissolution casting was carried out by the first pass and second-layer presentation, and it rolled out to tabular. Subsequently, in order to hold the confidentiality between these plates, after carrying out micro welding of the lamination part beforehand, it heated in 800 degrees C and atmospheric air, and extrusion molding between heat was carried out by the extrusion area ratio 80. The thin pure Ag layer was stuck to the second layer side of the material by which the knockout was carried out by pressure between heat on the same conditions as an example 1. After rolling out the obtained material further, it pierced in the shape of [as an example 1 / same] dimorphism, and the compound-ized material was obtained. Internal oxidation of the obtained material was carried out in the same procedure as an example 1, and it considered as the contact chip sample. The combination size of this final chip was the same as the example 1, and each thickness [each of] of 50 micrometers and a pure Ag layer of the thickness of the first pass was about 1 of chip total thickness/10.

[0051] The degree of hardness of the - second car layer and the thickness of the first pass were checked like the example 1 for a start [of the obtained contact chip]. The result is shown in Table 7. In addition, although not indicated in a table, any sample of the thickness of the pars intermedia was less than 100 micrometers. These contact chips were attached to the breaker of isomorphism like the example 1, and the electric trial was performed like the example 1. The result is also doubled and it is shown in Table 7.

[0052] After making two layers of compound-ized Ag alloy plates which were produced with casting from this result rival, that casting, the first, and the chemical composition of the second layer are the same, and manufacture of compound electric contact of this invention within the limits is possible for a degree of hardness and by using this contact further show that offer of the practically excellent breaker is also possible by extruding and rolling out between heat.

[0053]

[Table 7]

試料番号	化学組成	平均硬度 第一層 (mH.)	平均硬度 第二層 (mH.)	電気試験の結果（5段階総合評価） 耐溶着特性	初期の温度特性	過負荷試験後温度特性	耐久試験後温度特性	短絡試験温度特性
62	試料6に同じ	241	110	4	3	4	4	4
63	試料8に同じ	294	125	5	3	4	3	3

[0054] (Example 7) Compound electric contact with the same chemical composition of the - second car layer was produced with powder-metallurgy processing for a start with the samples 8 and 15 of Table 1.

After preparing Ag alloy powder of the chemical composition corresponding to these first, respectively and carrying out internal oxidation within rotary kiln on the same oxygen ambient atmosphere and temperature conditions as an example 1, in the mold, the laminating and restoration of each powder were carried out, it was pressed, and cylindrical preforming with a diameter [of 80mm] and a height [total] of 200mm was produced so that the first pass and the second layer might become the combination of the same presentation as samples 8 and 15. In addition, it was made for the part equivalent to the first pass in that case to become 1/10 of the whole. This preforming was heated in 800 degrees C and argon gas after that, extrusion molding between heat was carried out immediately, and it was made tabular. Subsequently, the thin pure Ag layer was stuck to the field by the side of the second layer of this knockout object by pressure between heat like the example 1. This material was rolled out further, and it pierced in the shape of [as an example 1 / same] dimorphism as the shape of a hoop, and considered as the electric contact chip sample. The combination size of a final chip was the same as the example 1, and each thickness [each of] of 50 micrometers and a pure Ag layer of the thickness of the first pass was about 1 of chip total thickness/10.

[0055] The degree of hardness of the - second car layer and the thickness of the first pass were checked like the example 1 for a start [of the obtained contact chip]. The result is shown in Table 8. In addition, although not indicated in a table, any sample of the thickness of the pars intermedia was less than 100 micrometers. These contact chips were attached to the breaker of isomorphism like the example 1, and the electric trial was performed like the example 1. The result is also doubled and it is shown in Table 8.

[0056] It turns out that offer of the breaker which was excellent also in the compound-ized contact produced with powder-metallurgy processing from this result practically that casting, the first, and the chemical composition of the second layer are the same, and manufacture of compound electric contact of this invention within the limits is possible for a degree of hardness and by using this contact further is also possible.

[0057]

[Table 8]

試料番号	化学組成	平均硬度 第一層 (mH$_v$)	平均硬度 第二層 (mH$_v$)	電気試験の結果（5段階総合評価） 耐溶着特性	初期の温度特性	過負荷試験後温度特性	耐久試験後温度特性	短絡試験温度特性
64	試料8に同じ	290	125	4	3	4	4	3
65	試料15に同じ	247	113	3	4	4	4	4

[0058]

[Effect of the Invention] Since electric contact of this invention consists of an Ag alloy of the two-layer structure containing Sn and In, the first pass with a high degree of hardness is allotted to a front face, the second layer with a degree of hardness lower than this layer is allotted to the interior and it is controlled at within the limits whose thickness of the first pass is 10-360 micrometers further as stated above, it has the contact electrical property which combines the outstanding joining-proof property which could not reach only with Ag alloy containing Cd conventionally, and the temperature characteristic. Therefore, instead of electric contact which consists of an Ag alloy containing Cd free, it can use as a contact for breakers. Furthermore, according to this invention, the breaker using the above electric contact can be offered.

[Translation done.]